Baptiste PONCHEL – 2025
Engineering Student

MY PORTFOLIO

Hello ! I'm an engineering student passionate about simulation topics and applied mathematics.

I am searching for an internship of 6 months in the mechanical simulation field. I am also wanting to become an researcher (I'm aiming for a PhD thesis), if it's possible, I would be really pleased to spend these months in a research laboratory.

Currently I am …

Traveling in South-East Asia to take part in volunteering missions. This goes from helping at schools to lending an hand to someone for a social works.

It permits me to get involved into more people-focused projects, to take a break before pursuing my studies and to deeply immerse myself in other cultures.

Volunteering in public and private schools.
Malang, Indonesia

Help in coffee and rice fields.
Pokhara, Nepal

SOMMARY

Thank you for your interest in my work. In this portfolio, you will find the most important projects I have worked on during my university studies.

Unfortunately, I will not be presenting the work I did during my six-month engineering assistant internship at CMD Gears (please see my resume). This is because all the projects I worked on while being in this company were confidential.

PROJECT 1 - **Birds Strikes and Fan Baldes ruptures in a Pratt&Whitney Turboreactor**

PROJECT 2 - **Study of the shockwave structures in a vulcan class motor**

PROJECT 3 - **Thermo mechanical studies of the heating of a braking disc (personal initiative project)**

PROJECT 4 - **Optimization of an industrial robot gripper**

AND OTHER PROJECTS

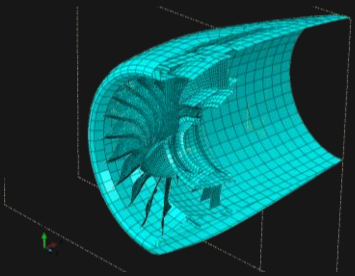
PROJECT 1

- 120 hours

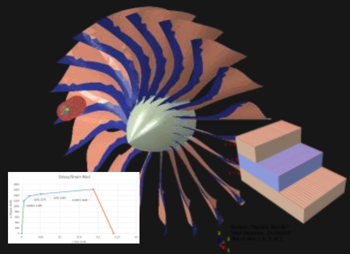
Birds Strikes and Fan Baldes ruptures in a Pratt&Whitney Turboreactor

This subject came to our mind when we had to find an object that must be conform to international rules regarding damage for our Crash and Contacts Simulation course. This case is a Turboreactor needing to pass the C-25 European certification related to Bird Strikes.

For that, we had to transform a CAD model made by an airplane enthusiast into a Mesh (mainly made of surfaces). Then we had to research the materials laws related to materials used for the reactor. After tuning the solver to handle contacts, rapid dynamics, plasticity and damage, we succeeded in simulating various tests on this reactor : Bird Strikes (after learning how to use of an SPH model), blades detachments and also various impacts. Finally, we had to post-process in order to see if the engine passes the test or no.

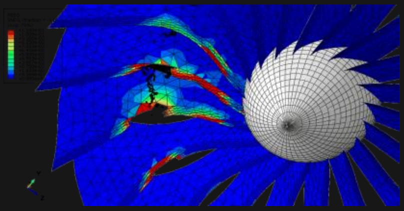


Mesh design
(we had to deal with limited computationnal ressources)

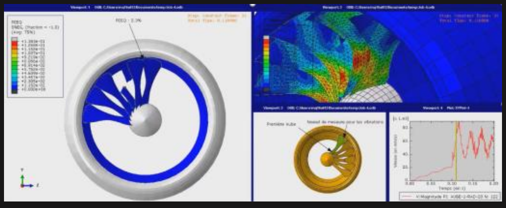


Damagable isotrope and composite materials modelizations

Explicit solver



Bird Strikes for various birds
(SPH coupled models)



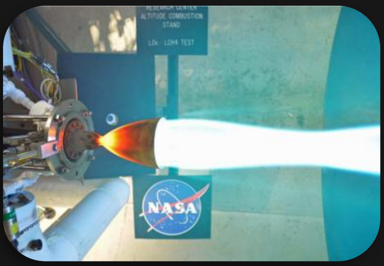
Blade detachement

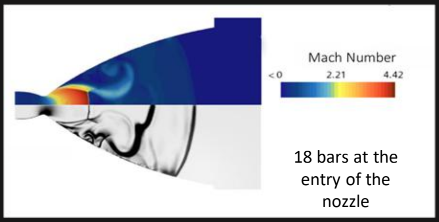
PROJECT 2

- 120 hours

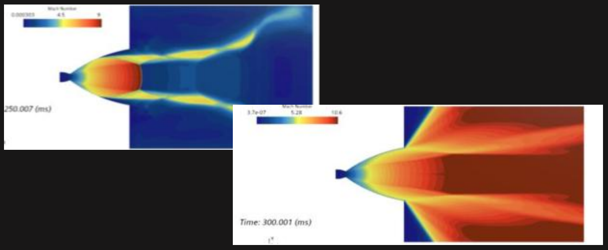
Study of the shockwave structures in a vulcan class motor

- Manage physical hypothesis (compressible gas, inlet parametres …)
- Pick the best turbulence model
- Find the best mesh refinment method





Study of thrust with a variation of the pressure at the entry of the nozzle



Study of the establishment (throught time) of the shockwaves for a fixed pressure

This subject was one of those proposed by our CFD and Multiphysics simulation teacher. When a reactor of a spatial jet starts, a lot of pressure and heat is created in the entry of the nozzle. The gas enters into a converging nozzle, is accelerated enough to reach Mach 1 at the switch between the converging and the diverging nozzle. The gas enters into a supersonic state and continues to accelerate through the diverging nozzle. The brutal change of pressure, speed and temperature between the gas leaving the nozzle (very low pressure) and the exterior creates shock waves. These shock waves can damage the nozzle and have a role into the thrust the motor can deliver.

To analyze this behavior, we did a compressible gas CFD simulation with Star-CCM+ where the difficulties were to find the more suitable turbulence model able to be gentle in shock waves zones and also generating a mesh refined enough in critical zones. To achieve this, we implemented a dynamic mesh refinement script that instructed the solver to refine the mesh near the shock waves at each time step.

During this simulation course, I also learned about various multiphysical couplings techniques such Fluid-Structures Interactions (FSI), Aero-Thermal or Aero-thermo-mechanical couplings as well as Multiphase simulation, ALE meshing, *etc* … .

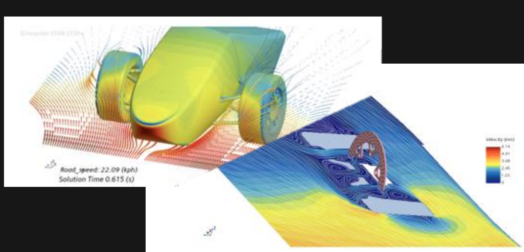
PROJECT 3

- 150 hours

Thermo mechanical studies of the heating of a braking disc (personal initiative project)

This study was initiated following a request from Formul'UT — my university's Formula Student team, for which I was responsible for finances during the 2024–2025 season. The team expressed a need to present a new brake sizing program to other teams and industry professionals. I proposed and led this project with the aim of developing simulation tools using Abaqus, enabling the team to perform both thermal and mechanical sizing of brake components, particularly for the brake discs.

To achieve this, I first needed to understand how the disc cools during vehicle operation. I then developed a thermo-mechanical coupled model and learned to implement Fortran subroutines, as Abaqus does not natively support certain dynamic boundary conditions — such as moving brake pads, variable disc cooling, and realistic braking cycles. I also ensured that the tool could be adapted to any race track, as long as we have telemetric data.



Aero-thermal coupled simulation (with turning wheels) to get the convective coefficient for variable car speed (0 to 100 km/h)

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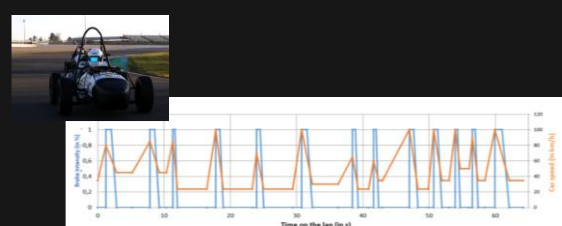
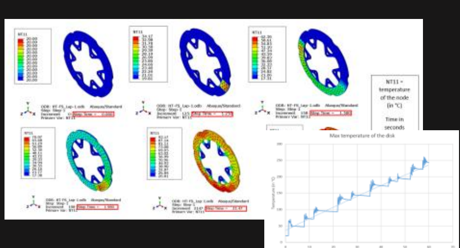
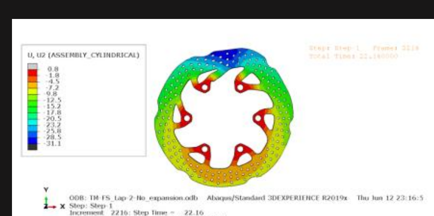


Create subroutines to change the limit conditions according to any track data (brake intensity and speed of the car)



With an implicit solver, I firstly wanted to know how the temperature would evolve within the disc for a special track lap



Finally, thanks to a thermo-mechanical semi-coupled solver, I found the stress among the disc

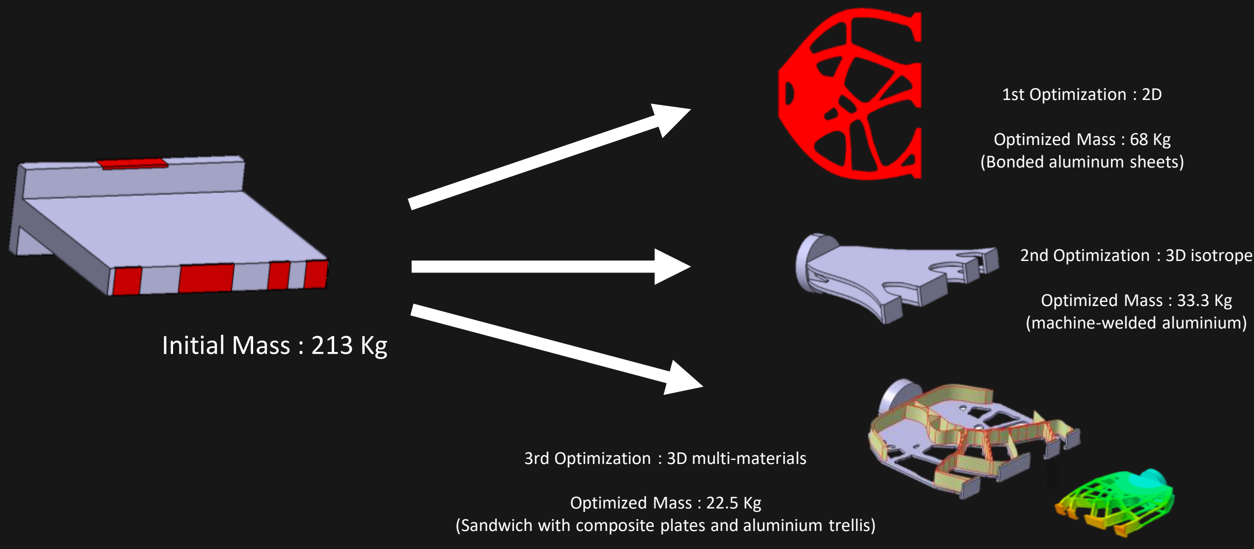
<u>My project is Open-To-Use ! (Video available)</u>

<u>Link :</u> https://github.com/baptiste622/Thermo-mechanical-simulation-of-a-braking-disc--using-Abaqus-.git

PROJECT 4

- 90 hours

Optimization of an industrial robot gripper



For this project, we needed to optimized the weight of an industrial robot gripper destined to travel while holding different types of wooden plates. For all optimization attempts, we use the OptiStruct solver combined to HyperMesh (Altair Suite). After expressing the optimization constrains (max stress, max displacements, different load cases, …), we had to choose the more accurate and efficient optimization mathematical method for our cases (SIMP, Lagrange's method, global methods, …).

After different attempts, we got different ready-to-manufacture solutions which were more or less light, rigid and easily manufacturable. It allowed me to know more about local and global optimization algorithms, their uses and their different limits.

While we were working on this project during our Optimization course, we also learned about many different types of optimization problems, such as:

- Multi-objective optimizations,
- Optimal approximation problems,
- Identification and Inverse problems,
- Fully-Stressed Design,
- … (And many other different topics)

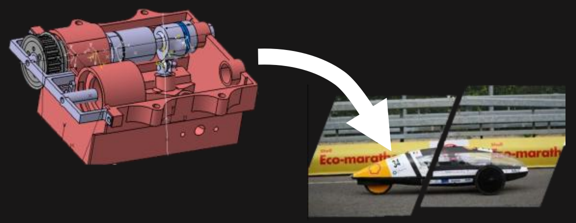
MATLAB ALTAIR

OTHER PROJECTS

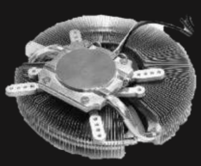
Conception of a variable distribution for a monocylinder motor

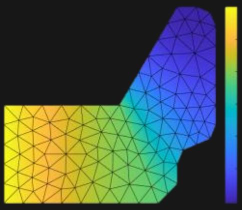
The objective of this project was to design a distribution system for a single-cylinder motor of a Shell Eco-Marathon vehicle. The specific challenge was to design it with variable valve timing (changing the moment when the valve will be pushed down) and variable valve opening duration (the duration when the exhaust or intake valve will be opened). The goal was to be able to optimize engine combustion by mechanically modifying these settings while the engine is turned off.

From collecting the needs to CAD



Adapting an FEM matlab code to study the cooling of one radiator blade





After getting introduced in coding an implicit FEM program, I had to adapt a mechanical code to suit a thermal problem where a radiator blade made of two distinct materials needed to cool down. The mesh was made using Gmsh.

Vibrational studies of an offshore wind turbine

For our structural dynamics course, we needed to study the reaction of an offshore wind turbine enduring various solicitations, we had to perform on our own model :

- A quasi-static study for different wind intensities.
- An harmonic study because of the sea swell.
- A study of the response to a magnitude 7.8 earthquake thanks to an accelerometer data and an spectral analysis out of the Eurocode 8.

After all these studies, we were able to know which vibration mode we should avoid and thus, have an hint of the structural changes we may do.